

Modern Concepts of Cardiovascular Disease

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THE CLINICAL USE AND LIMITATIONS OF TESTS OF CARDIAC FUNCTION

The increased interest in the employment of patients with cardiac disease has drawn attention to the clinical testing of cardiovascular function and the evaluation of cardiac reserve. Matching a patient's functional ability to the requirements of a given type of employment is an important part of the physician's duty. It is for obvious reasons desirable to evaluate the patient's work capabilities before the test imposed by the occupation itself. With this general purpose in mind, it is proposed to review briefly available methods of measuring cardiovascular function or so-called cardiac reserve.

Traditionally the physician evaluates the status of the patient's circulation by means of subjective symptoms and physical signs. Thus, relying predominantly on the patient's statements regarding his symptoms and ability to work, the physician places him in one of the categories outlined by the New York Heart Association as follows:

- Class I: No limitation of physical activity.
- Class II: Slight limitation of physical activity.
- Class III: Marked limitation of physical activity.
- Class IV: Unable to carry on any physical activity without discomfort.

This classification is obviously loose and open to variable interpretation. In patients with the same apparent amount of disease there may be considerable variation in the symptom response. Furthermore, the patient's attitude toward working and other emotional factors affecting him, may color his expression of symptoms. The large potential sources of error in subjective methods of disability evaluation has led to the search for more definitive means.

For the purposes of testing, circulatory function may be divided roughly into that of the circulation or blood flow as a whole, namely, the cardiac output, and the local circulation through certain special areas. Although the coronary circulation is the special area under consideration in the present discussion, there are similar problems in the evaluation of blood

flow elsewhere, as, for example, the skeletal muscles in patients with peripheral vascular disease.

Overall circulatory function. It is now possible to measure with relative accuracy the overall circulatory function or cardiac output in human beings. Probably the most widely used and accepted technique at present is the catheter method based on the direct Fick principle.¹ Unfortunately it is distinctly a procedure for the investigational laboratory and is not applicable to widespread clinical usage. It is important to point out, however, that even in laboratories where this method is available, the data obtained do not provide the answer to all problems regarding evaluation of circulatory function. So many factors contribute to alterations in cardiac output that an interpretation of a single result is usually difficult. Multiple determinations made with the stress of exercise may yield more information, but even then detection of lesser degrees of disability is difficult or frequently impossible. Although patients with advanced cardiac disease usually fail to respond to stress with an increase in cardiac output, the difference in response between the patient with mild cardiac disease and the normal subject may be impossible to detect.

If this rather discouraging viewpoint is accepted, then nothing additional can be expected from other simpler but more suspect means of determining cardiac output such as the ballistocardiograph, electrokymograph, and the pulse contour methods. Even if the results are valid, there still remains the difficulty of interpretation.

If adequate information cannot be obtained from a direct determination of the cardiac output, then it would appear that some related measurement may be of more value. The ballistocardiograph is a possible source of such information. There is evidence that persons with an abnormal circulation usually have an abnormal ballistocardiogram and that this may be of some prognostic significance.² Some individuals, however, with apparently normally functional cardiovascular systems may also have abnormal ballistic tracings. By the present

concepts it may be that the ballistocardiograph will become a useful means of screening for the presence or absence of cardiac disease, but it appears much less likely that it will be used to quantitate the degree of functional disability.

Other less direct means of testing overall cardiac function have been suggested. The measurement of vital capacity and breath holding time have been used for many years but have notable defects.³ The measurement of oxygen consumption under various circumstances or the measurement of the oxygen debt attainable under stress has been described.⁴ Others have suggested the use of the oximeter to study the response of the arterial oxygen saturation to a short period of relative anoxia.⁵ None of these tests has yet been accepted as an entirely satisfactory means of evaluating cardiac disability, but further studies along these lines may eventually yield results of greater usefulness.

For many years tests of cardiac "efficiency" or physical fitness have been used. The famous Schneider Index,⁶ a test of the pulse rate and blood pressure reactions to postural change and mild exercise, is an example in this category. Tests of this sort are beyond the scope of our present discussion but do bring up the fact that differences in training and athletic ability cause appreciable differences in performance and therefore tend to increase the difficulty in interpreting the functional measurements in patients with cardiac disease. Such tests, on the other hand, have the advantage of enabling the physician to view the patient as he exercises and to observe the development of his symptoms.

Coronary blood flow. A somewhat similar situation to that of testing the overall circulation exists in the analysis of coronary blood flow. A method is now available by means of which the coronary flow can be measured in man.⁷ Again it is a laboratory procedure of considerable magnitude, but the information at hand does not suggest that it would be a satisfactory clinical means for evaluating the various degrees of inadequacy in the diseased coronary circulation. Disease of the coronary vessels is usually spotty rather than diffuse so that overall blood flow values may be misleading. One is forced to more indirect methods of evaluating impaired myocardial blood supply. The two chief means used to date have been the study of the effect of calibrated exercise⁸ or of a short period of relative anoxia⁹ on the development of symptoms or on the production of alterations in the electrocardiogram. These methods may be of considerable value in the determination of the presence or absence of coronary artery disease in patients with otherwise questionable findings, but they are of little value, or are even contraindicated in patients with already diagnosed heart disease.

Even if accurate tests of circulatory function were available, a further major problem would remain. The tests, in general, give only evidence of what can be done in the way of a specific function but give no information regarding the possible unfavorable effects of the imposed load. If, for instance, a certain amount of work produces pain of myocardial ischemia, it is usually accepted as a detrimental response, and that level of work is regarded as being excessive. In many other situations, however, no such warning may appear. The prognostic significance of physical activity and other stresses cannot be deduced from the result of functional measurements but is based upon our concepts of the natural history of disease. At the present time the effect of a stress on the course of a disease cannot be determined by measuring the various cardiovascular functions involved.

In summary, there are at present very few, if any, reliable clinical tests which are useful to the physician in quantitatively evaluating the degree of disability caused by heart disease in a patient. The most accurate means still remains the careful and intelligent evaluation of the patient's history by the physician. This is a subjective interpretation and is fraught with many possible sources of error. Investigational laboratory means have advanced considerably in recent years so that many of the involved circulatory functions can now be relatively accurately measured in man, but these determinations still have not yielded a simple means of evaluating cardiovascular disability. Further research is necessary in an attempt to correlate measurements of cardiovascular function with the ability of the patient to perform a given activity. It will undoubtedly be true, however, that the physician's clinical appraisal will remain the keystone of the functional evaluation of the patient with cardiovascular disease.

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